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Consultative Committee for Space Data Systems

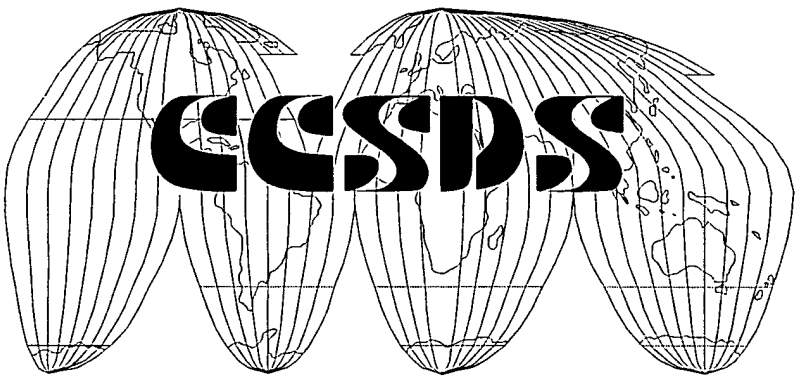
RECOMMENDATIONS FOR SPACE DATA SYSTEM STANDARDS

RADIO FREQUENCY AND MODULATION SYSTEMS—

PART 1
EARTH STATIONS AND SPACECRAFT

CCSDS 401.0-B

BLUE BOOK



2.4.17A MODULATION METHODS FOR HIGH SYMBOL RATE TRANSMISSIONS, SPACE RESEARCH, SPACE-TO-EARTH, CATEGORY A

The CCSDS,

considering

(a) that efficient use of RF spectrum resources is imperative with the increasing congestion of the frequency bands;

(b) that the SFCG has approved a Recommendation,[1] specifying a spectrum mask for *Space Research* Category A Space-to-Earth links operating in certain bands;[2]

(c) that suppressed carrier modulation techniques, such as FQPSK-B,[3] GMSK[4] and baseband filtered/shaped OQPSK[5] modulations, can meet the SFCG Recommended[1] spectrum mask for symbol rates in excess of 2 Msps;

(d) that FQPSK-B,[3] GMSK[4] and baseband filtered/shaped OQPSK[5] modulation types can be demodulated using a conventional OQPSK receiver, but with differing end-to-end losses;

(e) that GMSK,[4] baseband filtered OQPSK[5] and, with proper trellis demodulation/equalisation techniques, FQPSK-B[3] and shaped OQPSK[5] modulations have only a small performance degradation as compared with ideal unfiltered suppressed carrier systems;

(f) that most space agencies currently have conventional OQPSK receivers and many have no plans to modify their existing OQPSK ground station receivers to optimise reception of FQPSK-B,[3] and GMSK[4] signals, so that these two modulation techniques will incur greater losses than filtered OQPSK;[5]

(g) that the link performance of FQPSK-B[3] modulation exhibits greater losses than GMSK;[4]

(h) that FQPSK-B, GMSK and baseband filtered/shaped OQPSK modulations have immunity to interference (wideband and narrow band) comparable to unfiltered BPSK when demodulated with a OQPSK receiver matched to an unfiltered OQPSK waveform; the interference immunity of these modulations when demodulated with matched filter receivers is equivalent to or better than BPSK;

recommends[6]

that, to comply with the SFCG Recommendation[1] and to ensure an ability to obtain cross-support in certain *Space Research* service bands[2] FQPSK-B,[3] or GMSK[4] or baseband filtered/shaped OQPSK[5] be used for Space-to-Earth transmissions when the telemetry data symbol rates exceed 2 Msps.

NOTES:

1 See SFCG Recommendation 17-2R1 or latest version.

2 Category A bands are: 2200-2290 MHz and 8450-8500 MHz.

3 Feher-patented Quadrature Phase Shift Keying modulation. For further information, contact DIGCOM Inc, El Macero, Ca, USA.

4 Gaussian Minimum Shift Keying ($BT_B = 0.25$), with pre-coding see CCSDS 413.0-G-1).

5 Filtered (Square Root Raised Cosine $\alpha = 0.5$) Offset QPSK; Butterworth 6 poles, $BT_B = 0.5$ or Shaped Offset QPSK-A, -B; agencies may also utilise baseband-filtered OQPSK modulation with other types of filters provided that they ensure compliance with note 1 above and interoperability with the cross-supporting networks.

6 Space agencies requiring cross-support should consider the performance degradation of the filtered/shaped OQPSK, GMSK, and FQPSK modulation techniques when received with unmatched demodulators at existing ground stations (see performance data in CCSDS 413.0-G-1); the ordering of modulation types does not imply a preference.

2.4.17A MODULATION METHODS FOR HIGH SYMBOL RATE TRANSMISSIONS, SPACE RESEARCH, SPACE-TO-EARTH, CATEGORY A

The CCSDS,

considering

(a) that efficient use of RF spectrum resources is imperative with the increasing congestion of the frequency bands;

(b) that the SFCG has approved a Recommendation,[1] specifying a spectrum mask for *Space Research* Category A Space-to-Earth links operating in certain bands;[2]

(c) that suppressed carrier modulation techniques, such as FQPSK-B,[3] GMSK[4] and baseband filtered/shaped OQPSK[5] modulations, can meet the SFCG Recommended[1] spectrum mask for symbol rates in excess of 2 Msps;

(d) that FQPSK-B,[3] GMSK[4] and baseband filtered/shaped OQPSK[5] modulation types can be demodulated using a conventional OQPSK receiver, but with differing end-to-end losses;

(e) that GMSK,[4] baseband filtered OQPSK[5] and, with proper trellis demodulation/equalisation techniques, FQPSK-B[3] and shaped OQPSK[5] modulations have only a small performance degradation as compared with ideal unfiltered suppressed carrier systems;

(f) that most space agencies currently have conventional OQPSK receivers and many have no plans to modify their existing OQPSK ground station receivers to optimise reception of FQPSK-B,[3] and GMSK[4] signals, so that these two modulation techniques will incur greater losses than filtered OQPSK;[5]

(g) that the link performance of FQPSK-B[3] modulation exhibits greater losses than GMSK;[4]

(h) that FQPSK-B, GMSK and baseband filtered/shaped OQPSK modulations have immunity to interference (wideband and narrow band) comparable to unfiltered BPSK when demodulated with a OQPSK receiver matched to an unfiltered OQPSK waveform; the interference immunity of these modulations when demodulated with matched filter receivers is equivalent to or better than BPSK;

recommends[6]

that, to comply with the SFCG Recommendation[1] and to ensure an ability to obtain cross-support in certain *Space Research* service bands[2] FQPSK-B,[3] or GMSK[4] or baseband filtered/shaped OQPSK[5] be used for Space-to-Earth transmissions when the telemetry data symbol rates exceed 2 Msps.

NOTES:

1 See SFCG Recommendation 17-2R1 or latest version.

2 Category A bands are: 2200-2290 MHz and 8450-8500 MHz.

3 Feher-patented Quadrature Phase Shift Keying modulation. For further information, contact DIGCOM Inc, El Macero, Ca, USA.

4 Gaussian Minimum Shift Keying ($BT_B = 0.25$), with pre-coding (see CCSDS 413.0-G-1).

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6 Space agencies requiring cross-support should consider the performance degradation of the filtered/shaped OQPSK, GMSK, and FQPSK modulation techniques when received with unmatched demodulators at existing ground stations (see performance data in CCSDS 413.0-G-1); the ordering of modulation types does not imply a preference.

AUTHORITY

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